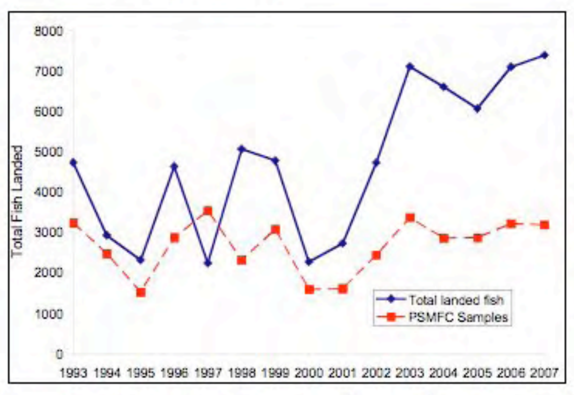
Trends in Abundance Surveys of Nearshore Rocky Reef Fishes in Central California

Tom Wadsworth[1] and Rick Starr[1,2]

[1]Moss Landing Marine Laboratories, [2] UC Sea Grant Extension Program

Introduction

Accurate abundance time-series data may prevent stock collapses seen in other California fisheries from occurring in the nearshore rocky reef. The nearshore rocky reef fishery targets three main groups: nearshore rockfishes (*Sebastes* spp.), surfperch (family Embiotocidae) and solitary predators (families Hexigrammidae and Cottidae). The recreational catch is much higher than commercial for most species in these groups, and may be increasing since 2000 (see graph below). This trend escalates the need to insure that stocks are healthy.



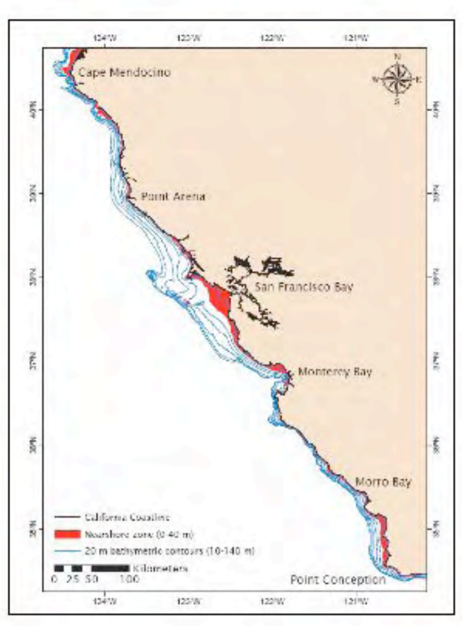
Trends in recreational charter and private vessel catches of nearshore rocky reef assemblage. Data are a sub-sample of total recreational catches as recorded by Pacific States Marine Fisheries Commission (PSMFC) dockside samplers 1993-2007.

Stock assessments are based on population dynamics models composed of data from indices of abundance, fish landings and life history data. Abundance data (i.e. fish counts) collected by field surveys have the potential to be useful for stock assessments if the data meets certain criteria. These data can help validate population dynamics models by tracking changes in stock abundance over time. Stock assessment models are designed to be influenced most by indices with greater sampling precision. Six nearshore rocky reef species assessments have been accepted by the Pacific Fishery Management Council (PFMC).

Study Goals

1. Evaluate existing abundance survey data for defining stock trends and sampling variability
2. Compare surveys of the same nearshore rocky reef species
3. Provide information to strengthen future stock assessments
4. Suggest species priorities for future stock assessments

Methods



Study Area:

- Cape Mendocino to Pt. Conception
- Subtidal nearshore (low tide-40 m)
- Rock seafloor habitat (rocky reefs)

Study Species Criteria:

- Regularly found in study area
- Commonly caught

Survey datasets analyzed for this study included:

- Data on adult fish of at least one study species
- At least two samples each year in the study area
- Effort measurements (e.g. hours fished, transect size)
- At least 4 years of data with the same methods

Data Analysis

- Generalized linear model (GLM) with negative binomial distribution
- GLM Response variable = fish count and effort
- Explanatory variables were added to models based on survey records
- GLMs provided a relative index of yearly stock abundance trends without bias of explanatory variables
- A yearly coefficient of variation (standard deviation/mean) was calculated with a jackknife technique as a measure of precision
- Linear regressions from GLM yearly values were used to assess trend directions for each species in each survey

Results

Species Scientific Name	Common Name	Mean Occurrence
Sebastes mystinus	Blue rockfish	0.577
Ophiodon elongatus	Lingcod	0.425
Sebastes serranoides	Olive rockfish	0.379
Sebastes atrovirens	Kelp rockfish	0.321
Sebastes carnatus	Gopher rockfish	0.340
Hexagrammos decagrammus	Kelp greenling	0.305
Sebastes chrysomelas	Black & yellow rockfish	0.270
Embiotoca lateralis	Striped surfperch	0.260
Sebastes melanops	Black rockfish	0.241
Sebastes miniatus	Vermilion rockfish	0.251
Scorpaenichthys marmoratus	Cabezon	0.234
Damalichthys vacca	Pile surfperch	0.205
Sebastes caurinus	Copper surfperch	0.217
Sebastes ruberrimus	Yellowtail surfperch	0.161
Sebastes rastrelliger	Grass surfperch	0.121
Sebastes pinniger	Canary rockfish	0.125
Sebastes nebulosus	China rockfish	0.096
Sebastes auriculatus	Brown rockfish	0.058

The 18 fish species used in this study, ranked by proportion of total survey samples that included each species (occurrence) averaged across all surveys.

Survey Acronym	Full Dataset / Study Title	Years used
CDFG SCUBA	Marine Reserve Fish Density and Habitat	1995-1998
PISCO SCUBA	Collaborative Central CA Abundance Surveys	1999-2007
TENERA SCUBA	Diablo Canyon Nearshore Reef Survey	1976-2007
CDFG H&L	Central CA Marine Sportfish Hook&Line Survey	1978-1982
CDFG CENCAL	Survey of CENCAL Spearfish Tournaments	1959-2006
CPFV Logbooks	Commercial Party Fishing Vessel Logbooks	2001-2007
CDFG Observers	CPFV On-Board Sampling Program	1988-1998
PSMFC Observers	MRFSS/CRFSS - Onboard Observers Survey	1999-2007
PSMFC Dockside	MRFSS/CRFS - Dockside Boat Surveys	1980-2007

The nine abundance surveys of study species used in analyses.

Species	CDFG SCUBA	PISCO SCUBA	TENERA SCUBA	CDFG H&L	CDFG CENCAL	CPFV Logs	CDFG Obsrvr	PSMFC Obsrvr	PSMFC Docksd
S. mystinus	-	High	Mid	Mid	Low	High	High	High	High
O. elongatus	Mid	Mid	-	Mid	Mid	High	High	High	High
S. serranoides	High	High	-	Mid	Mid	-	High	High	High
S. atrovirens	High	High	-	Mid	Low	-	**Low**	**Low**	Mid
S. carnatus	High	High	-	High	-	High	High	High	Mid
H. decagrammus	High	-	-	Low	Mid	High	Mid	Mid	High
S. chrysomelas	Mid	High	-	-	Low	-	Low	-	
E. lateralis	-	High	High	-	Mid	-	-	-	-
S. melanops	Mid	High	-	**Low**	Low	-	Mid	High	High
S. miniatus	Mid	Mid	-	Mid	**Low**	-	High	High	High
S. marmoratus	Mid	High	-	**Low**	Mid	High	Mid	Mid	High
D. vacca	-	High	Mid	-	Mid	-	-	-	-
S. caurinus	Mid	Mid	-	Mid	**Low**	High	High	Mid	High
S. ruberrimus	-	-	-	-	-	-	High	High	High
S. rastrelliger	-	-	-	-	Low	-	-	-	-
S. pinniger	-	-	-	**Low**	-	High	High	High	High
S. nebulosus	-	-	-	Low	-	-	High	High	High
S. auriculatus	-	-	-	-	-	-	High	High	High

Relative precision in survey samples, from mean yearly CVs. 'High' precision was CVs < 0.30, 'Low' were CVs > 0.70, with extremely low precision (>1.0) in bold.

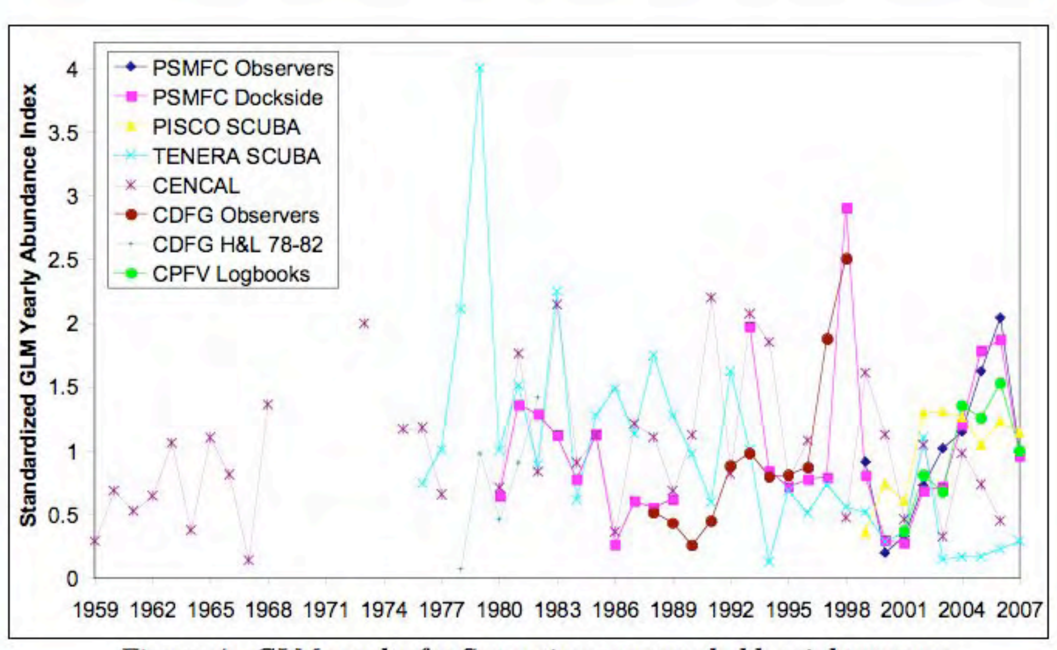


Figure A. GLM results for S. mystinus as sampled by eight surveys

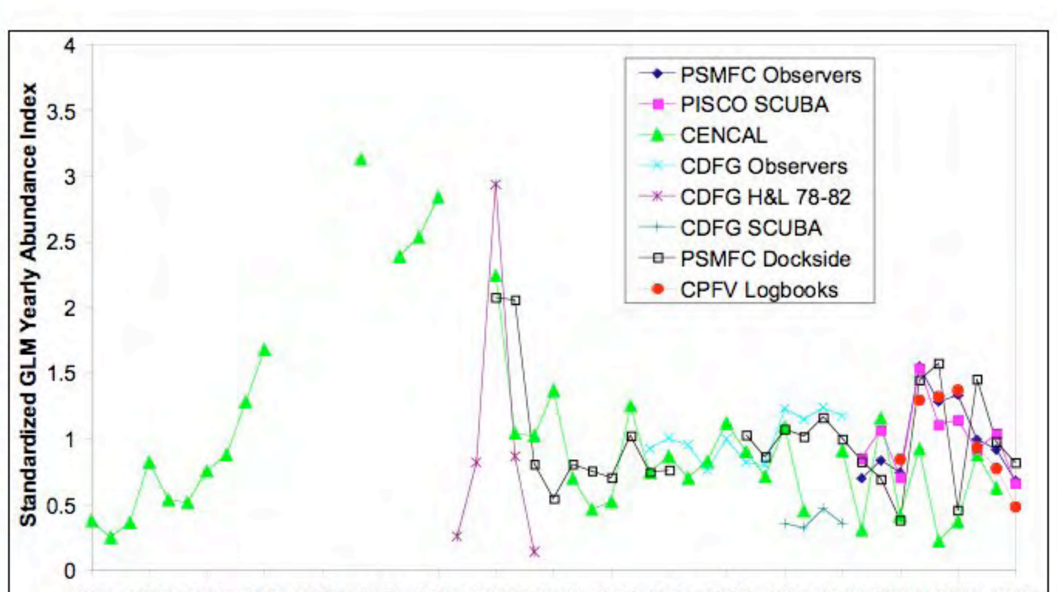


Figure B. GLM results for O. elongatus as sampled by eight surveys

The two species abundance plot examples given above show differences in overall trends and agreement among surveys. *S. mystinus*, fluctuated greatly in abundance over study years and had moderate agreement among survey trends (Fig. A). *O. elongatus* had greater clarity in trends and better agreement among surveys (Fig. B).

Species	CDFG SCUBA	PISCO SCUBA	TENERA SCUBA	CDFG H&L	CDFG CENCAL	CPFV Logs	CDFG Obsrv	PSMFC Obsrv	PSMFC Docksd
S. mystinus	--	↑*	↓*	↑	↑	↑	↑*	↑*	↑
O. elongatus	↑	0	--	↓	↓	↓	↑	↑	↓
S. serranoides	↑	↓	--	↓	↑	--	↑*	↑*	↑*
S. atrovirens	↓	↓*	--	↑	↓	--	↑*	↓	--
S. carnatus	↓	↑*	--	↑	↓	--	↑*	↑	↑*
H. decagrammus	↓	--	--	↑	↓*	↓	↑	↑	0
S. chrysomelas	↓	↓	--	--	↑*	--	↑	--	--
E. lateralis	--	↓*	0	--	↑*	--	--	--	--
S. melanops	↓	0	--	↓	↓*	--	↑	↑	↑*
S. miniatus	↑	0	--	↑	↑	--	↑	↑*	↑
S. marmoratus	↑*	0	--	↑	↓	↓*	↑	0	0
D. vacca	--	↓*	0	--	↑*	--	--	--	--
S. caurinus	↓	↓	--	↑	↓*	↑	↓	↑	↑
S. ruberrimus	--	--	--	--	--	--	↑	↑	↓
S. rastrelliger	--	--	--	--	0	--	--	--	--
S. pinniger	--	--	--	↓*	--	↑	↓	↑	↓*
S. nebulosus	--	--	--	0	--	--	↓	↑	↑
S. auriculatus	--	--	--	--	--	--	↑	↑	↑*

Results of linear regression using GLM yearly index of abundance values for all survey years. Direction of trends based on regression slope (↑=up, ↓=down, 0= no trend).
*(--) = no counts or too few samples taken. * Statistically significant slope (α <0.05)*

Discussion

Most surveys began in 1980 or after, some overlapped in time but many did not. When trends among surveys were compared for a given species, differences were often not significant, indicating that year of sampling is important in determining abundance levels. Many species showed fluctuating abundance trends since 1980, possible explained by changes in fishing pressure (i.e. landings) or ocean conditions (nutrient availability, water temperature and kelp density) over this time-period.

Sampling methods may contribute to differences in occurrence levels, precision levels and survey abundance trends. SCUBA and fishery-dependent surveys often gave different results. Surveys with extremely limited spatial and depth ranges (e.g. TENERA SCUBA) often differed from results of other surveys. Many species were more commonly counted in some surveys, but not in others. Most surveys did not demonstrate the same abundance trends for all species, supporting the need to assess each species independently.

Conclusions

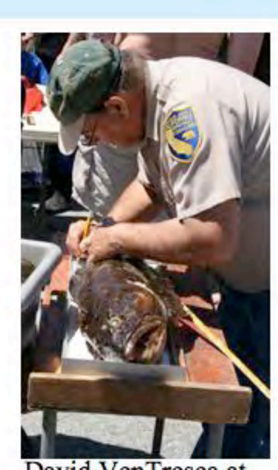
Each survey analyzed was unique in methods or time-period sampled. Most species were sampled at high enough precision to make one or more useful indices of abundance. It seems clear that more samples in the proper habitats can result in higher yearly sampling precision. Precision was highest in fishery-dependent hook-and-line surveys and SCUBA surveys for most species. Using precision as a criteria, trends for some species such as *O. elongatus* and *S. miniatus* are better defined using fishery-dependent surveys, while fishery-independent surveys are more precise for other species like *S. atrovirens* and *S. chrysomelas*. However, it is also important to consider the time-series length or methods (e.g. fishery-dependent vs. -independent) in deciding which surveys to use for fisheries management.

Of species that do not have an accepted stock assessment: *S. caurinus*, *S. serranoides*, *S. miniatus*, *H. decagrammus*, *D. vacca* and *E. lateralis* declined in abundance for at least one survey. These species should be high priorities for future assessments. For those species that have been assessed, no existing assessment used more than two of the datasets I analyzed. My results sometimes differed from these assessments, indicating that future re-assessments of these species could benefit from the inclusion of data sources analyzed here.

Acknowledgements

I wish to acknowledge the assistance of my thesis committee: Drs. Richard Starr, Greg Cailliet and Michael Graham

The project was made possible by the aid of the following data managers who provided (and often collected) the data I analyzed: David VenTresca (CDFG), Wade Van Buskirk (PSMFC), Deb Wilson-Vandenberg (CDFG), Dan Malone (PISCO), Wendy Dunlap-Harding (CDFG) and Jay Carroll (TENERA).



David VenTresca at CENCAL Meet 2006

The aid of Edward Dick was indispensible for analysis